The role of fibrous plants in cleaning polluted soil

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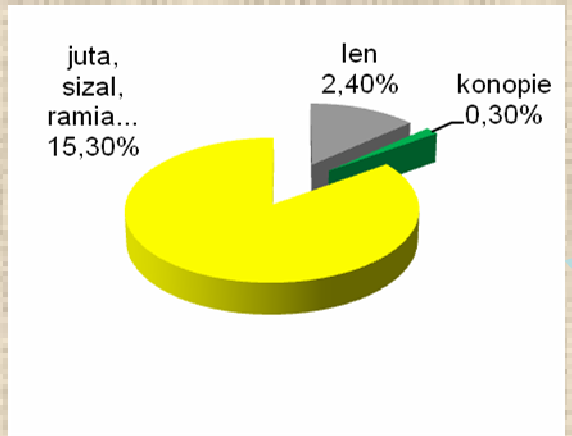
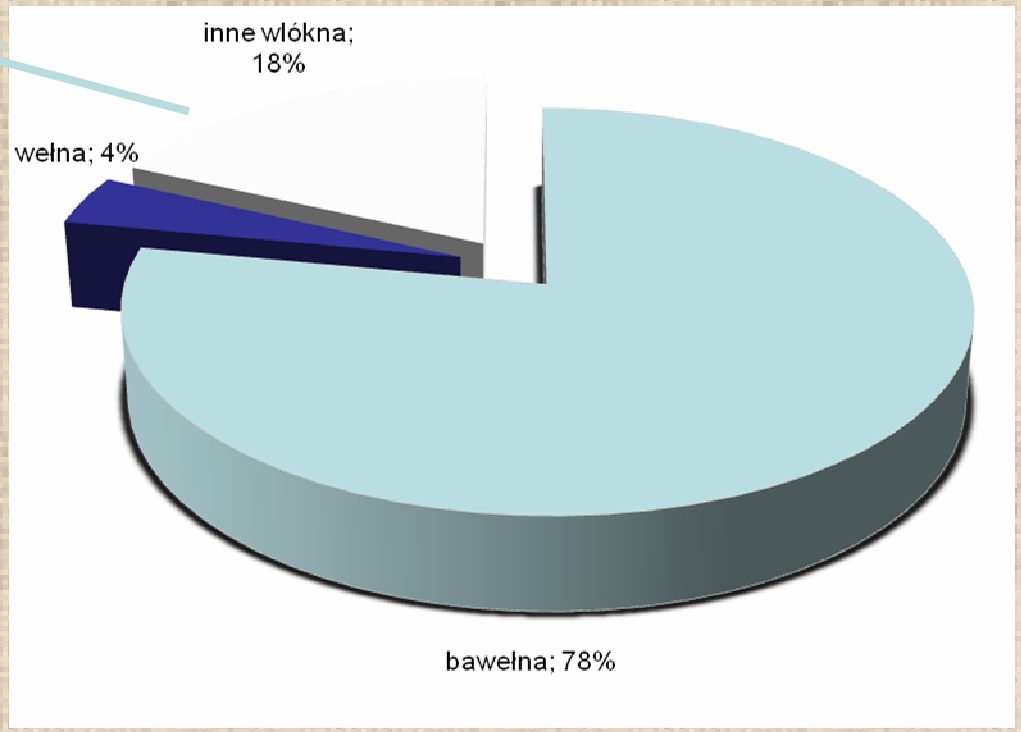
1st Thematic workshop of Crops2Industry EU Project

"Can the fibre crops offer a viable alternative land use option and could they support a competitive industry?"

18 November 2009
Institute of Natural Fibres and Medicinal Plants, Poznan, POLAND

Year 2009 – International Year of Natural Fibres by UNO and FAO





Cotton

Sida
(Hibiscus cannabinus)

Sisal *(Agave sisalana)*

Curaua
(Ananas erectifolius)

Cabuya

Abaca

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Flax

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Hemp

Industrial hemp plants in the field

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Narcotic hemp

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Monoecious hemp

Dioecious hemp

Monoecious hemp on the field

Dioecious hemp on the field

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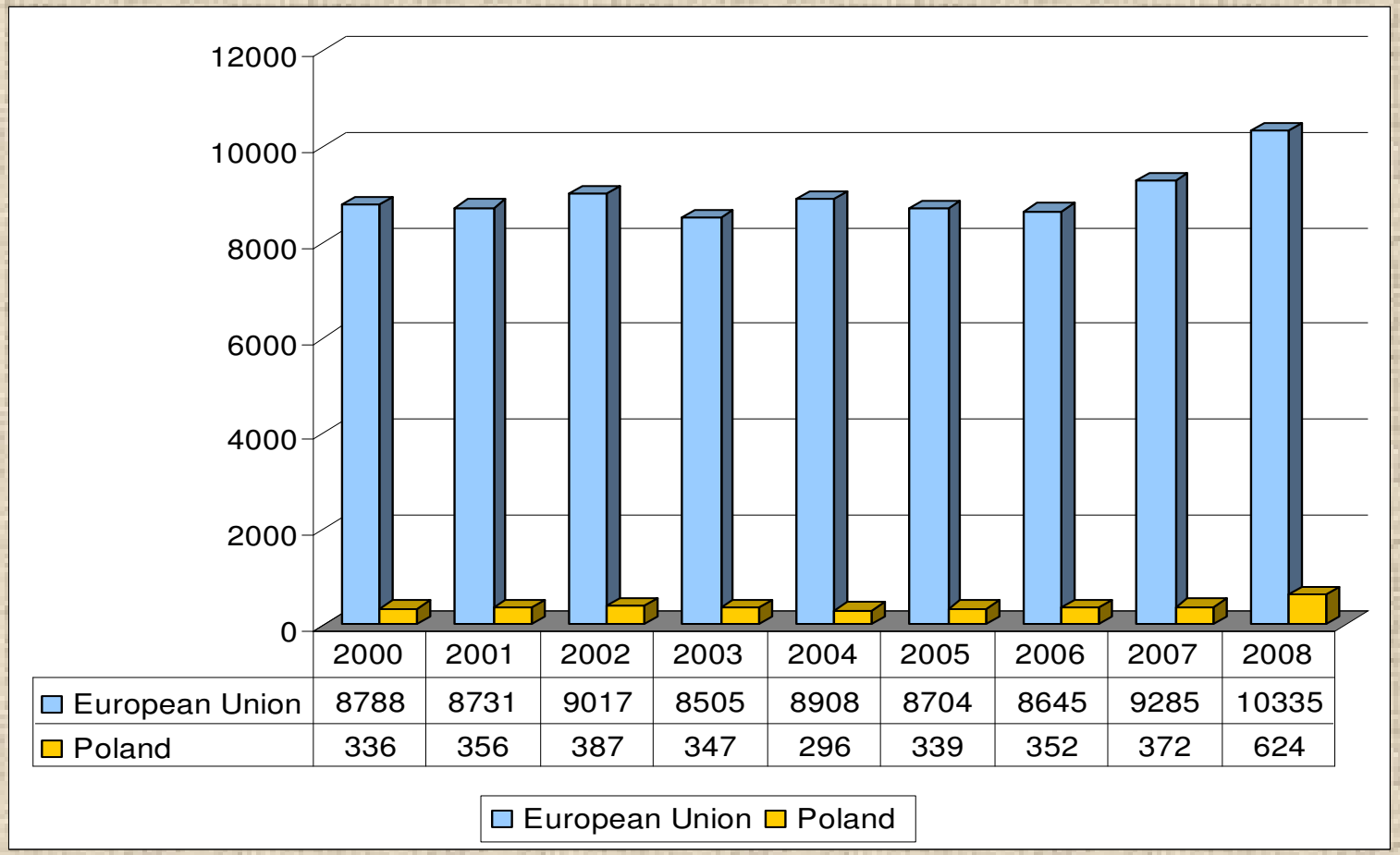
Why we choose hemp ?

- guarantee the acquisition of high and stable yield
- good for grains forecrop.
- improve soil structure .
- covered by EU subsidies and supplements
- 10 tons of hemp from ha extract up to: 2500kg CO2 netto

Pesticides and Hemp – a contrast view

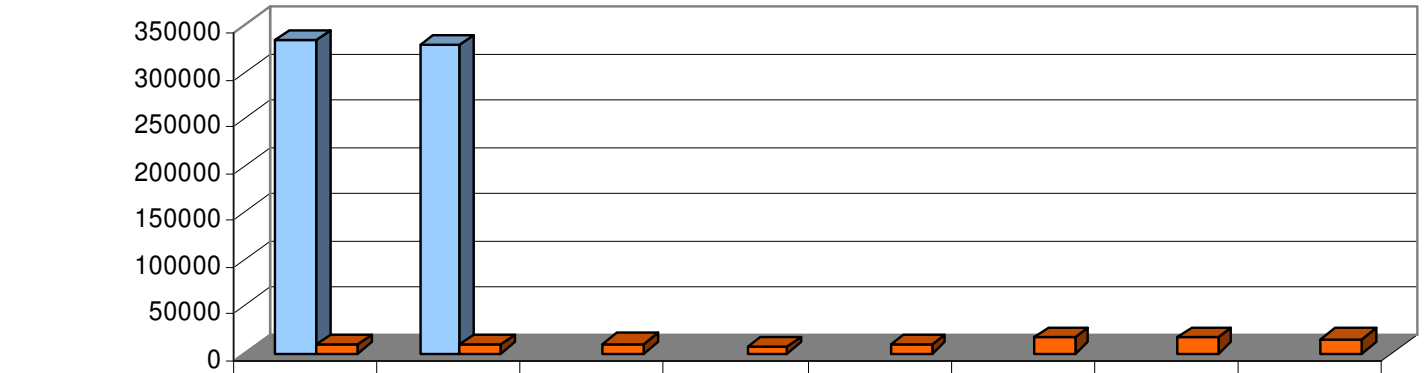
Plant protection products in UE and Poland 2000-2008 in milions Euro



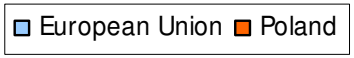
	2000	2001	2002	2003	2004	2005	2006	2007	2008
European Union	8788	8731	9017	8505	8908	8704	8645	9285	10335
Poland	336	356	387	347	296	339	352	372	624

Data: eurostat

Sales of pesticides (tons of AS years 2000-2007)

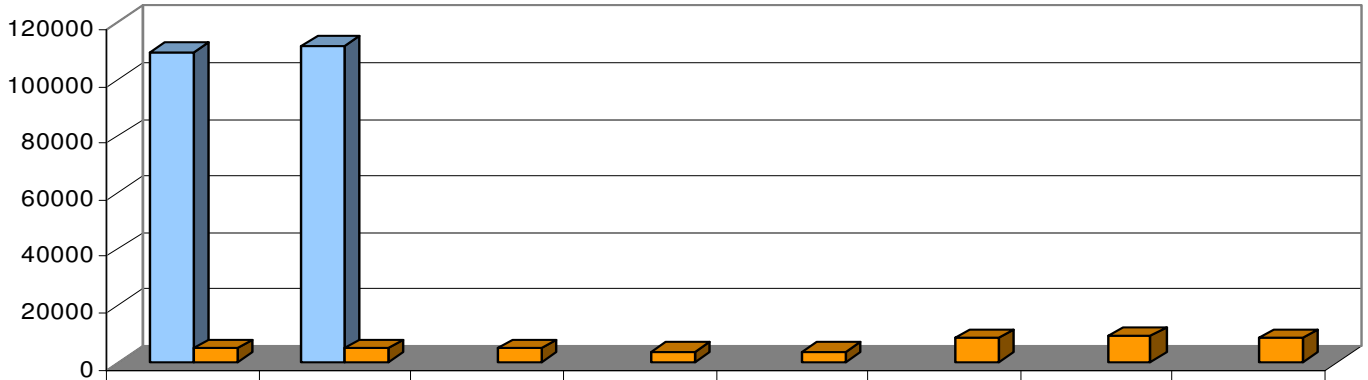


	2000	2001	2002	2003	2004	2005	2006	2007
European Union	332807	327642						
Poland	8848	8855	10358	7184	8726	16039	17102	15303

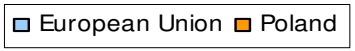


Data: eurostat

Sales of herbicides (tons of AS years 2000-2007)



	2000	2001	2002	2003	2004	2005	2006	2007
European Union	109486	111833						
Poland	4795	4748	4926	3772	3740	8381	9317	8435



Data: eurostat

Hemp Allelopathy

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Condition of hemp cultivation on polluted areas

Hemp on low pH (3,5) soil

Hemp on polluted area

Hemp on municipal sewage sediments

Stem harvesting

Seed/stem harvesting

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Tebeco hemp stem harvester

Blücher hemp harvester

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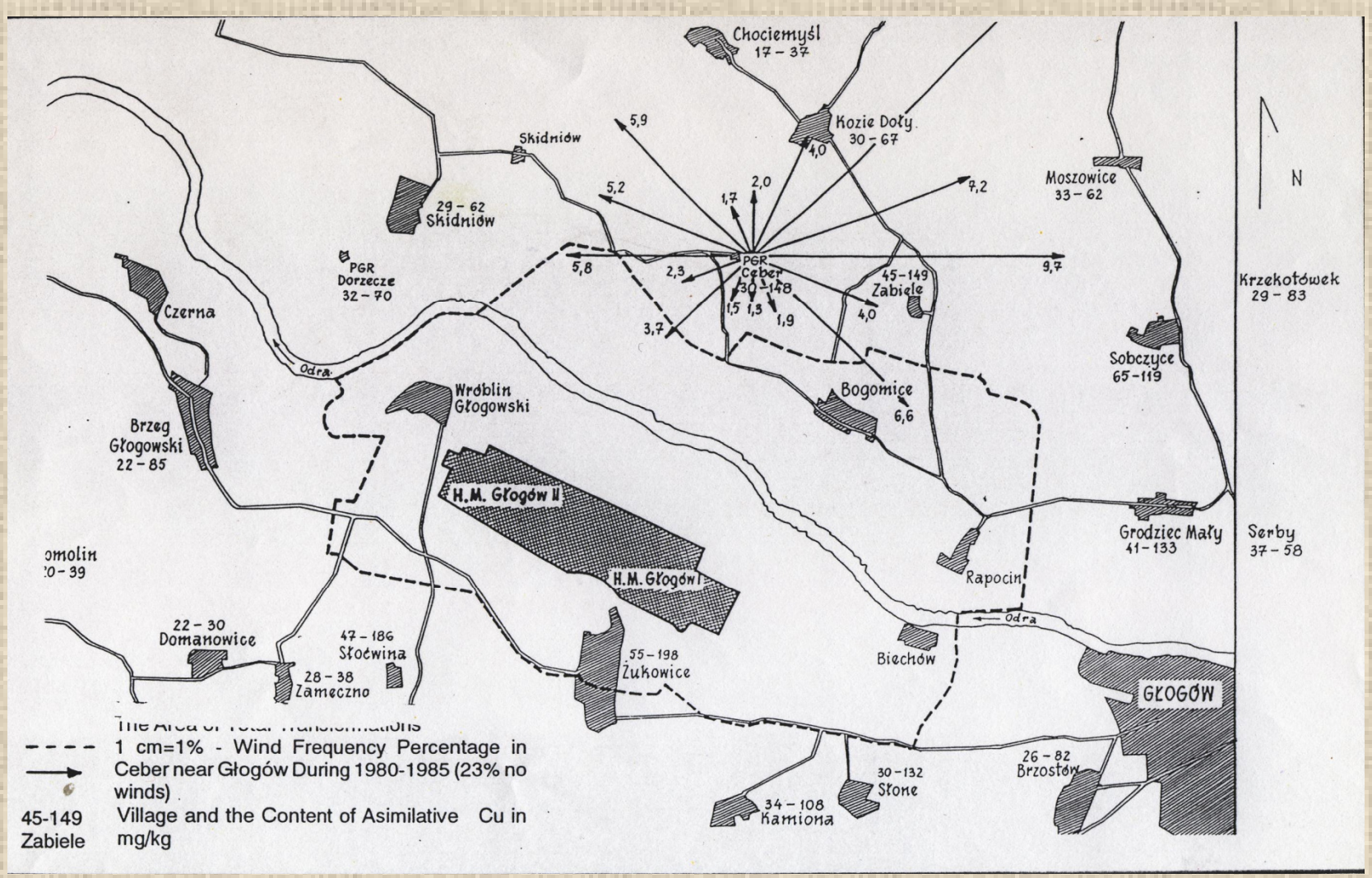
MATERIALS AND METHODS

The research was conducted in the safety buffer zone of the Copper Smelter in Głogów, with two Polish varieties of hemp: Beniko and Białobrzeskie

In order to evaluate the level of soil contamination the soil samples were taken. Prior the sowing, and after the harvest the soil was tested for Cu, Pb, Zn and Cd content.

Both soil and plant material were tested on the Perkin Elmer 3110 atom mass spectrometer. The analyses results were compared with the maximum allowable concentrations of relevant metals. The whole plant material for yield evaluation was sampled.

During the period of vegetation the observations of plant growth and development were carried out.



Safety buffer zone of the Copper Smelter in Głogów

Table 1. Maximum allowable concentrations of heavy metals in the soil [ppm]

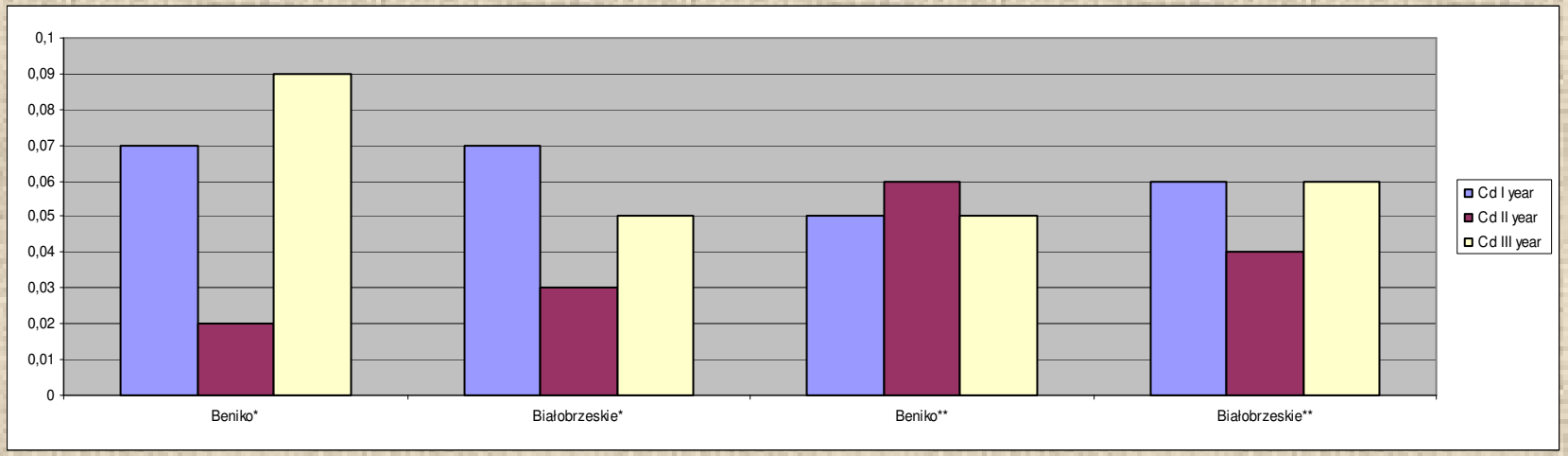
Metal	Maximum allowable concentrations of metal	
	Light soils	Heavy soils
Copper	50	100
Lead	50	100
Zinc	200	300
Cadmium	3	3

RESULTS

Table 2. The average content of tested elements in the soil in three years of experiment [ppm]

Element	Biechów area			Zukowice area		
	1994	1995	1996	1994	1995	1996
Cadmium	>0.5	0.21	0.22	>0.5	0.19	0.28
Copper	183	82.24	86.59	160	79.98	51.69
Lead	70	17.9	15.18	55	19.8	7.55
Zinc	40	14.37	20.57	46	16.42	20.57

The content of Cadmium [ppm] in hemp stems in Biechów area.



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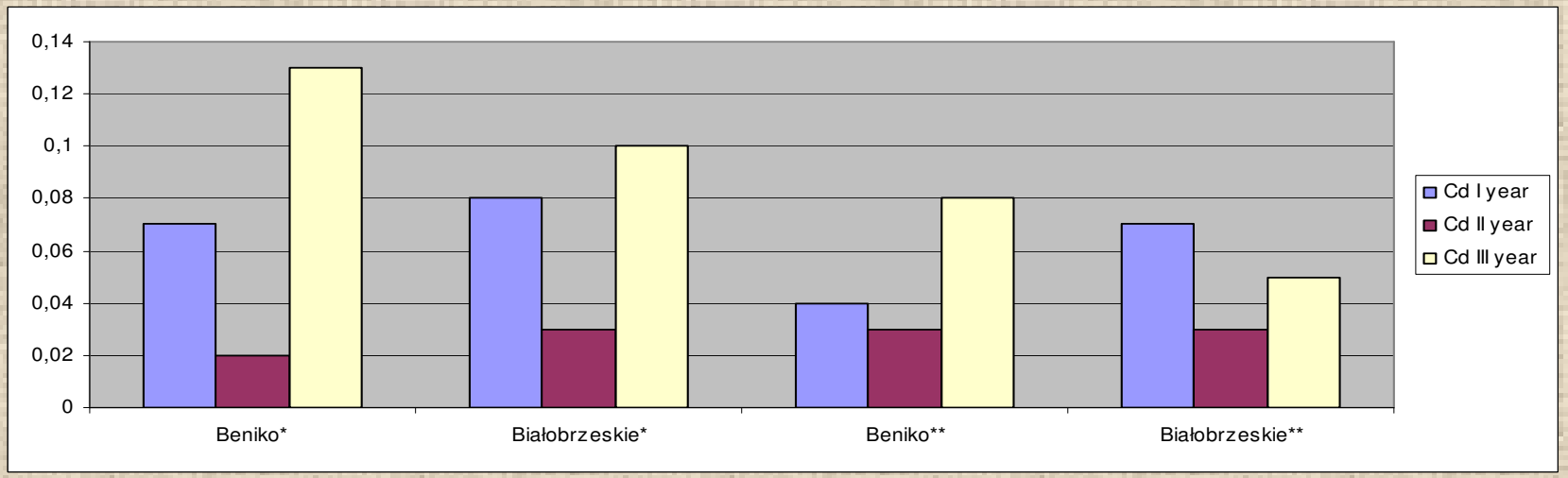
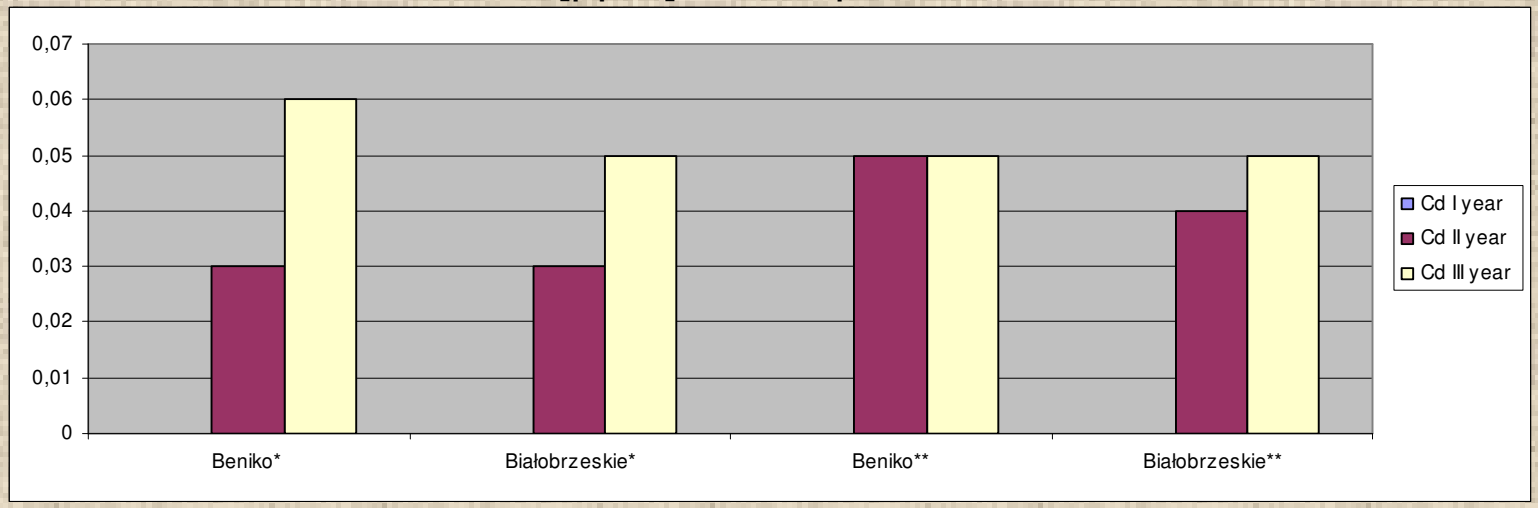
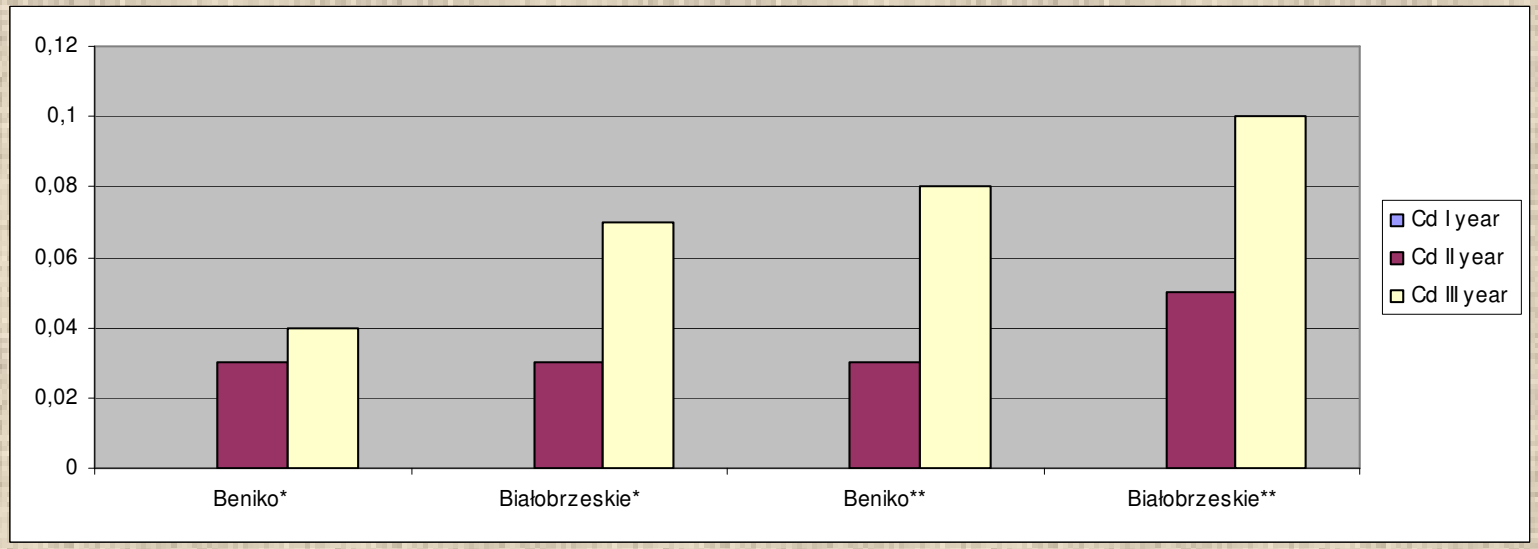


*fertilization variant: 60 kg N; 70 kg P2O5; 90 kg K2O
**fertilization variant: 120 kg N; 100 kg P2O5; 180 kg K2O

The content of Cadmium [ppm] in hemp stems in Żukowice area



The content of Cadmium [ppm] in hemp seed in Żukowice area



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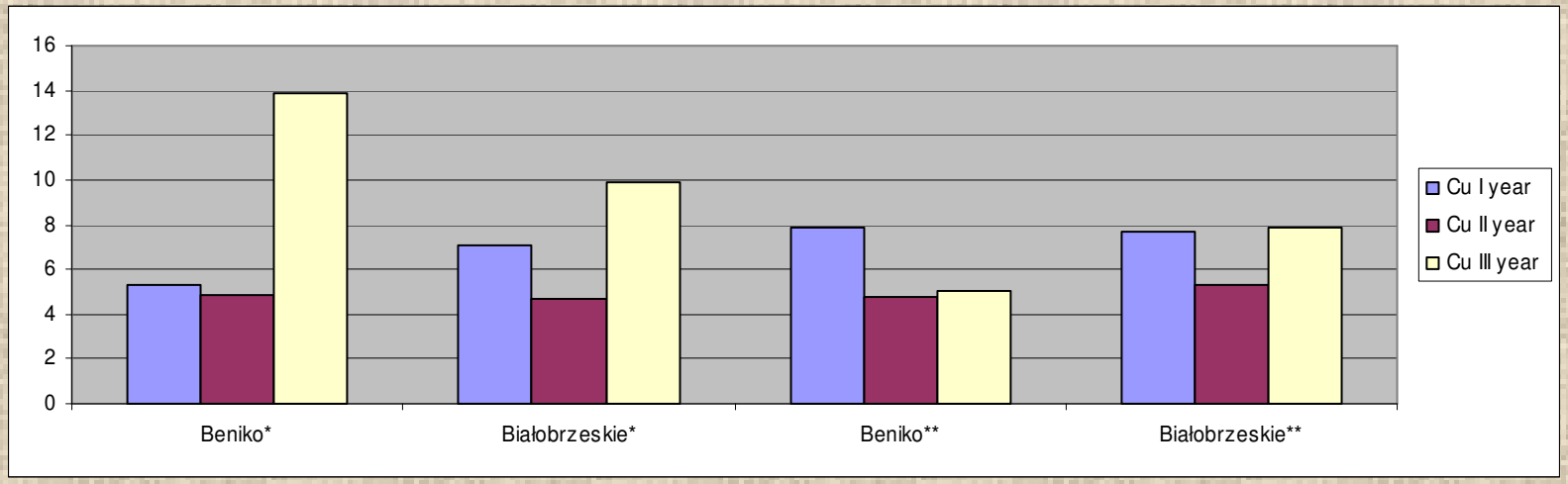
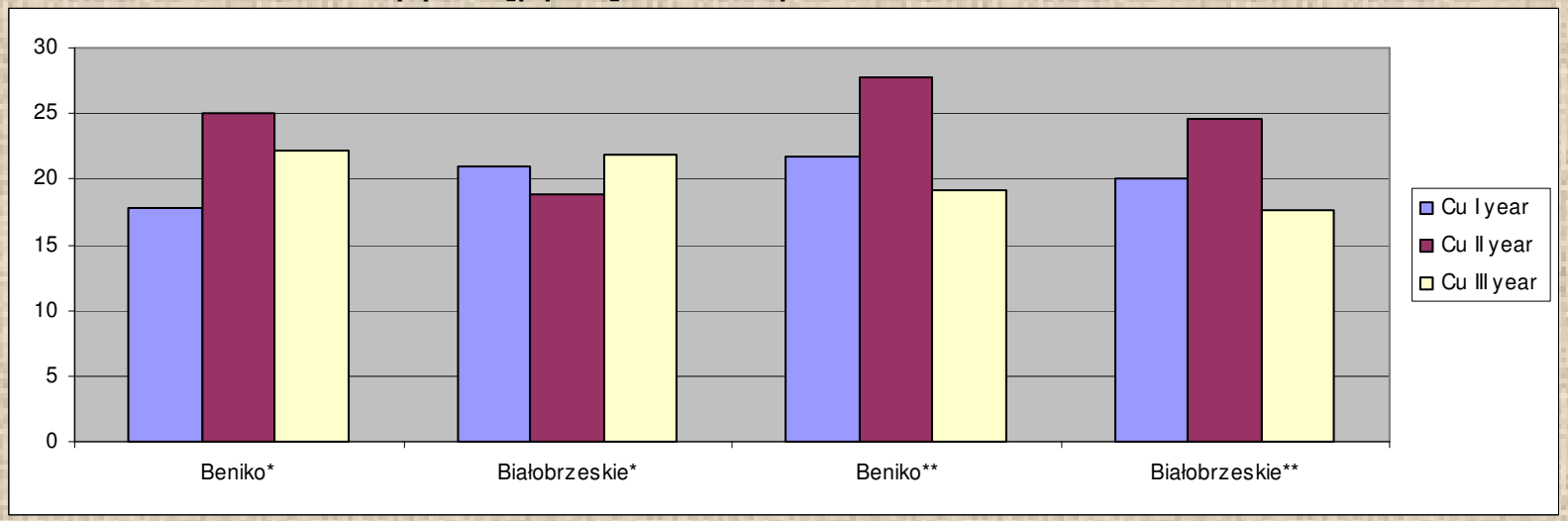
The content of Copper [ppm] in hemp stems in Biechów area.



The content of Copper [ppm] in hemp seed in Biechów area.



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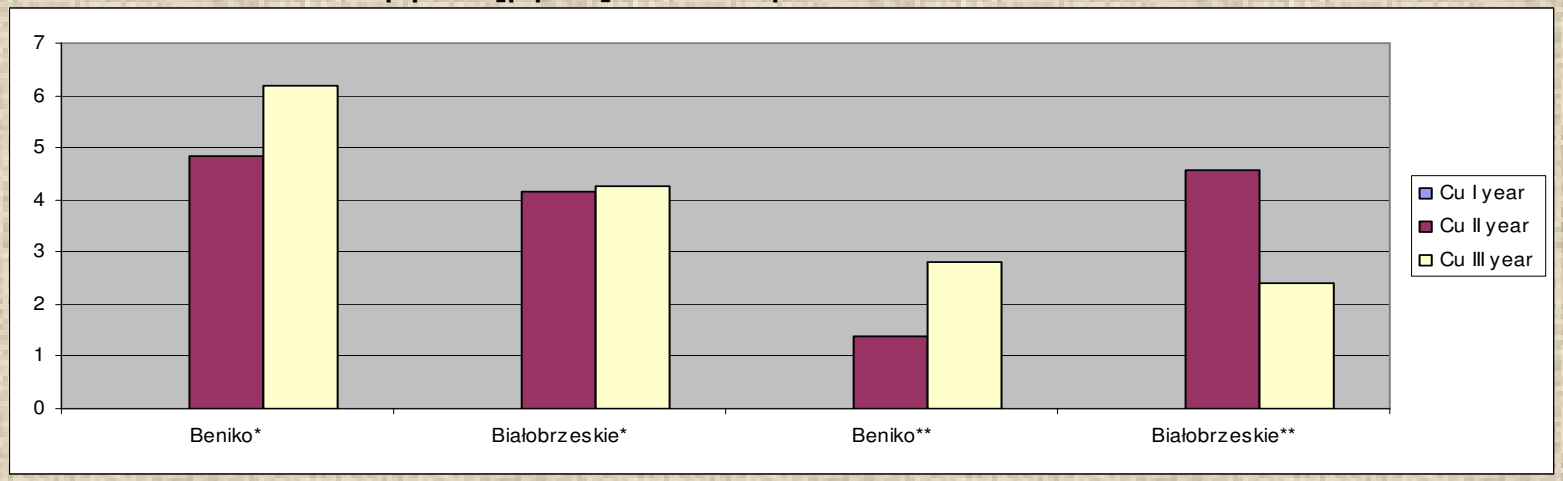

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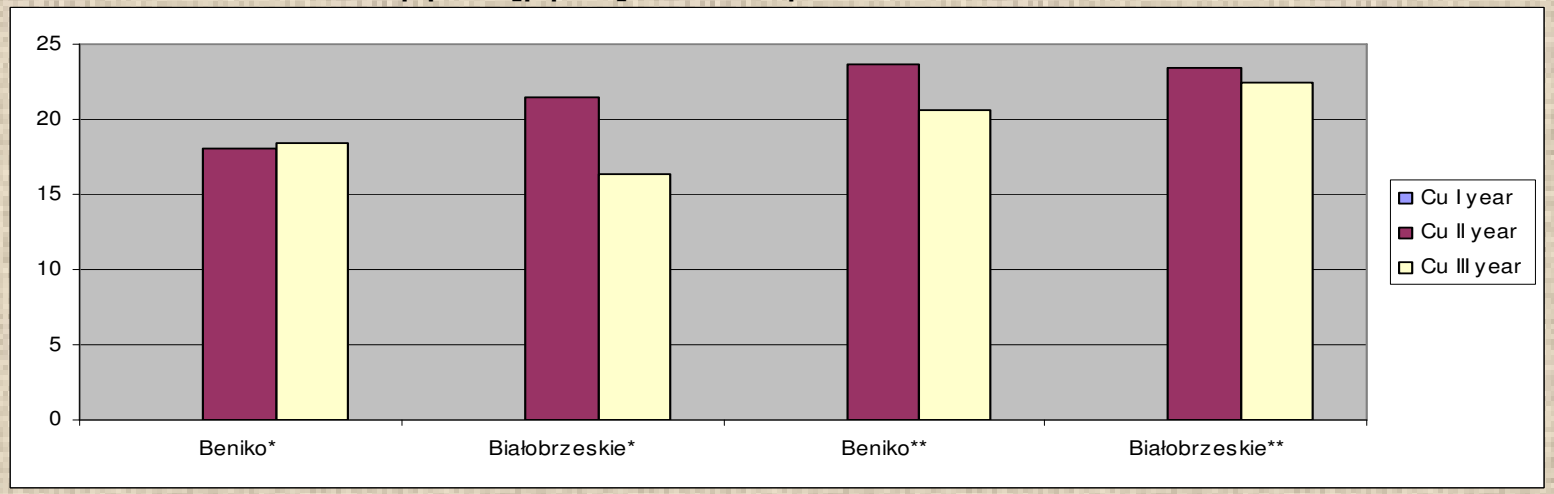

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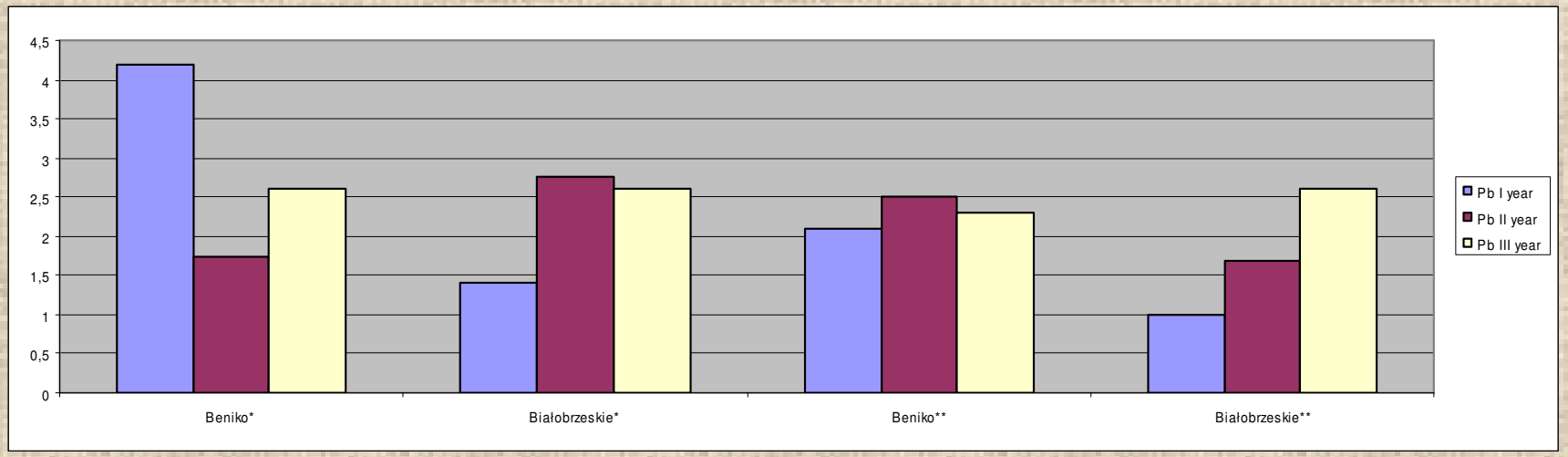
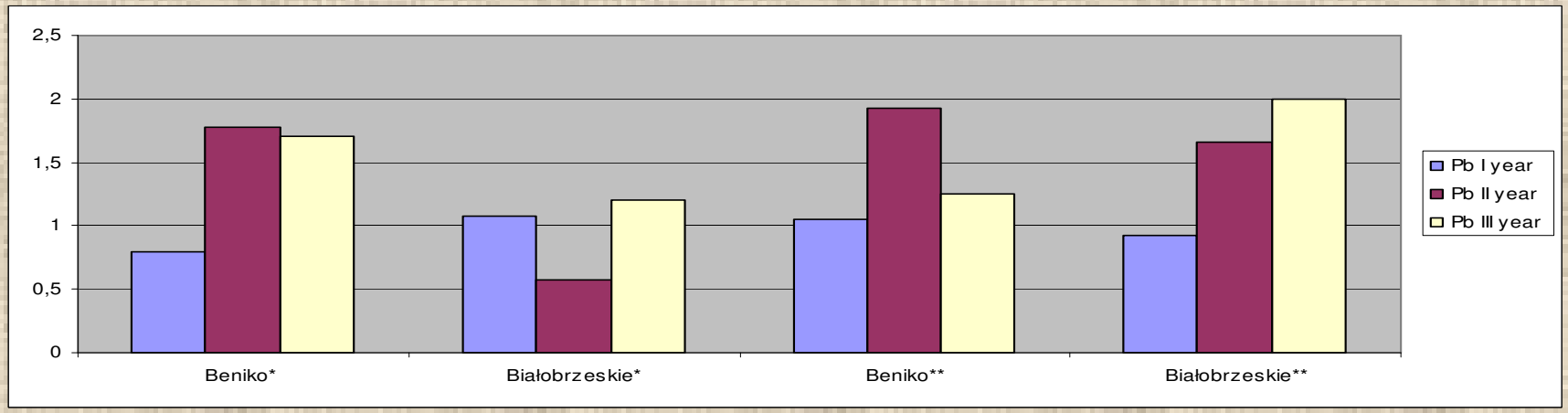
The content of Lead [ppm] in hemp stems in Biechów area.



The content of Lead [ppm] in hemp seed in Biechów area.



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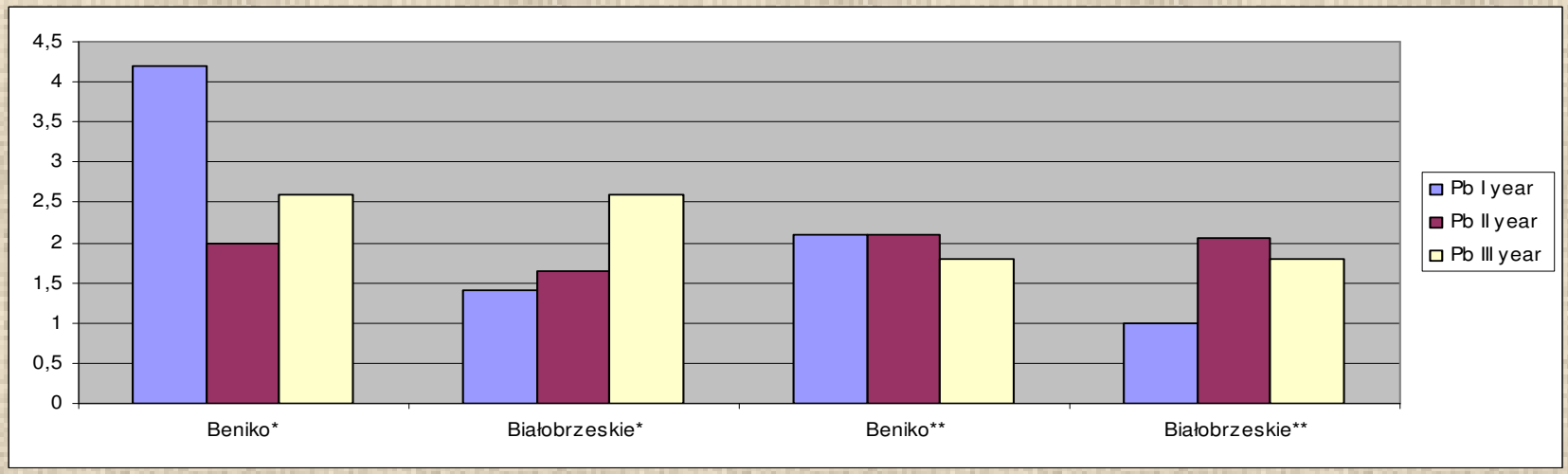

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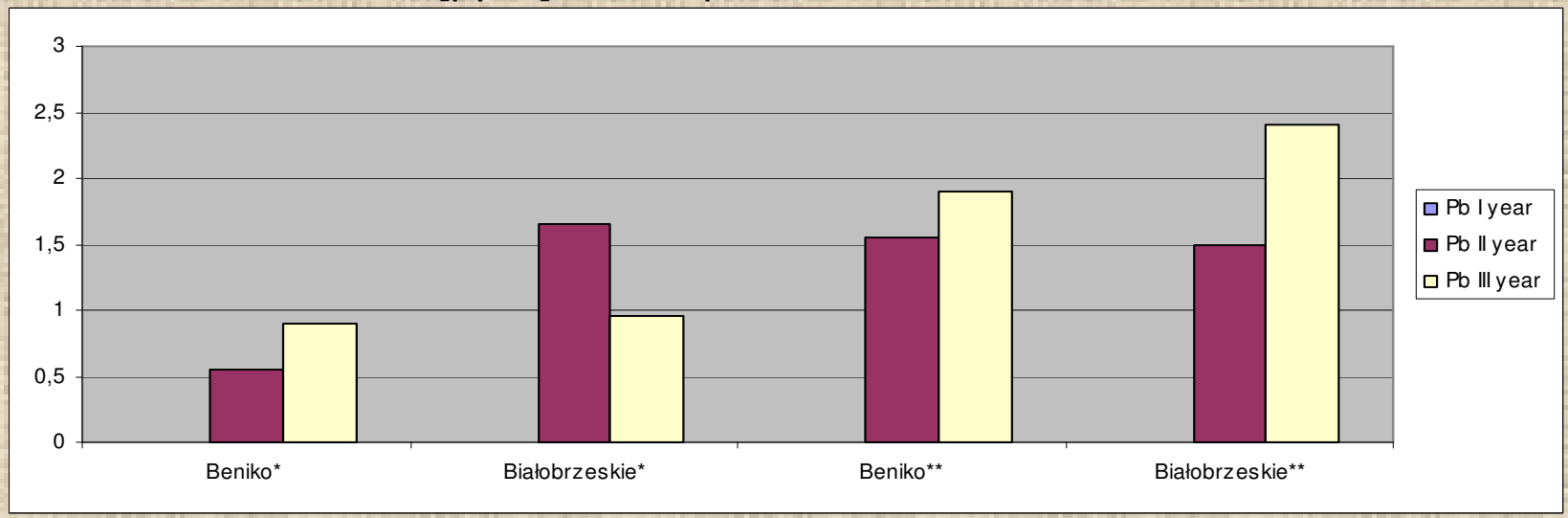

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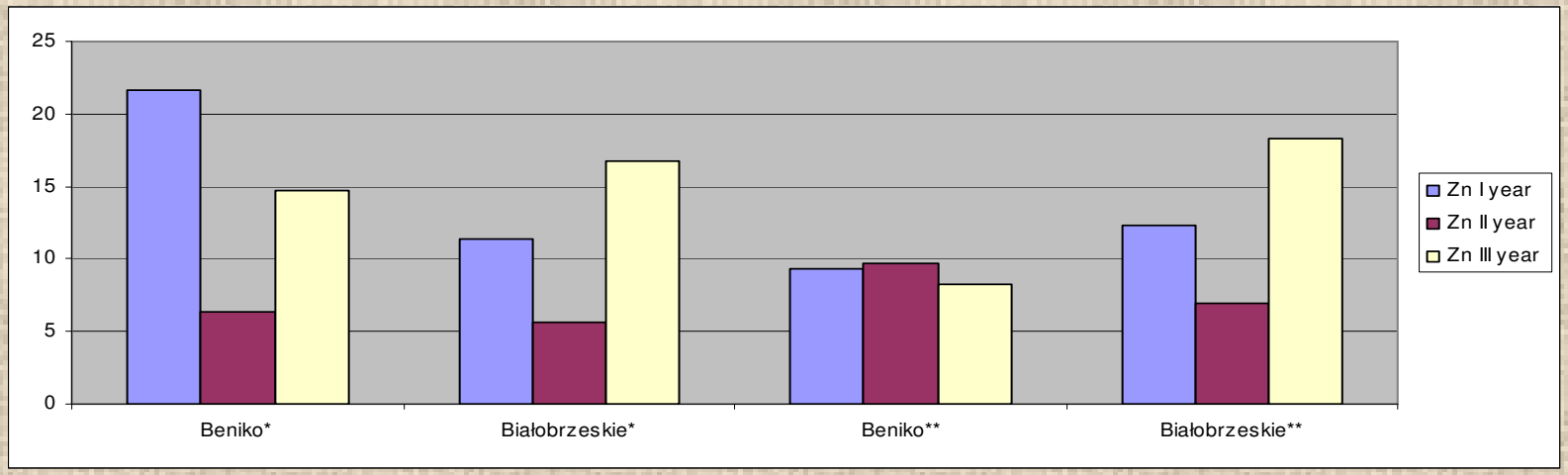
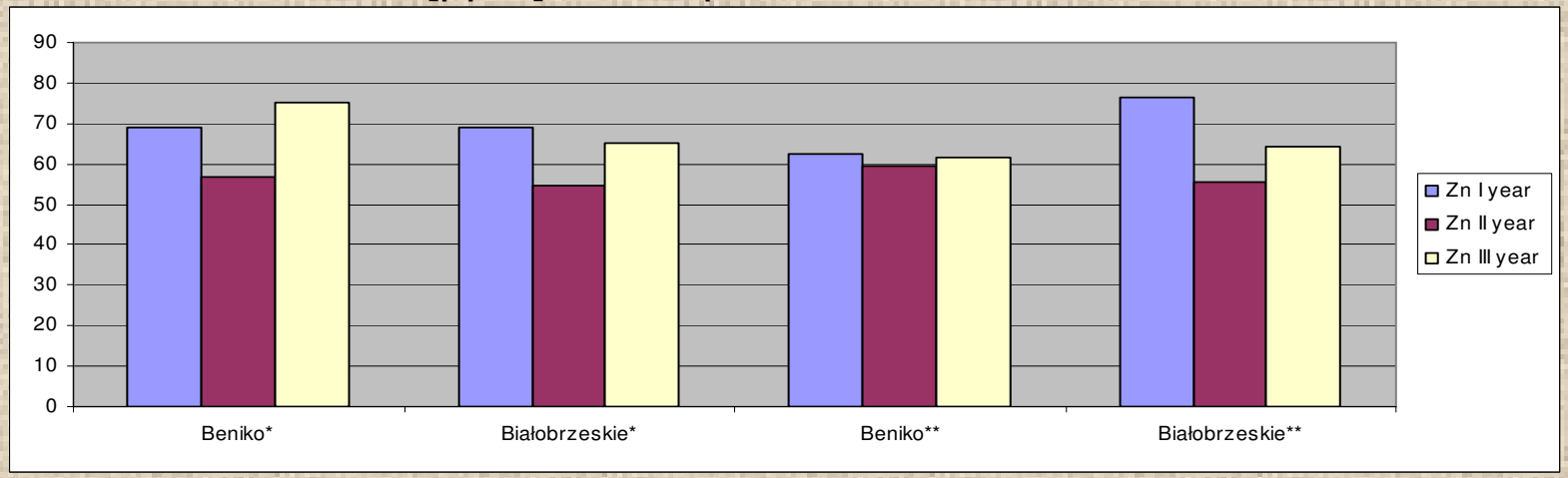
The content of Zinc [ppm] in hemp stems in Biechów area.



The content of Zinc [ppm] in hemp seed in Biechów area.



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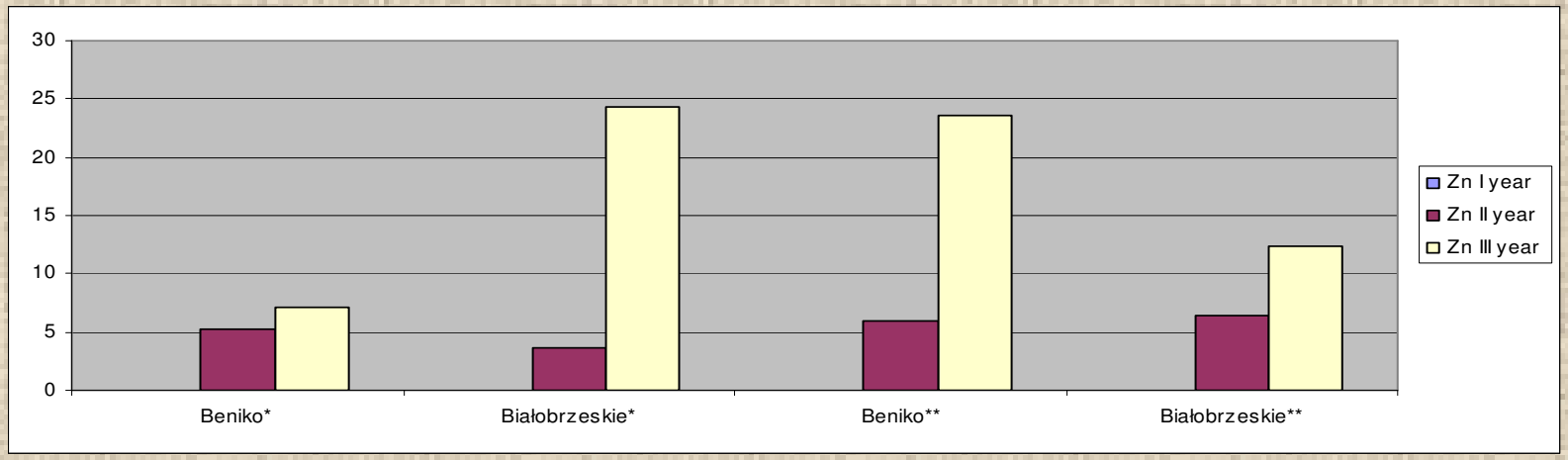
The content of Zinc [ppm] in hemp stems in Żukowice area



The content of Zinc [ppm] in hemp seed in Żukowice area

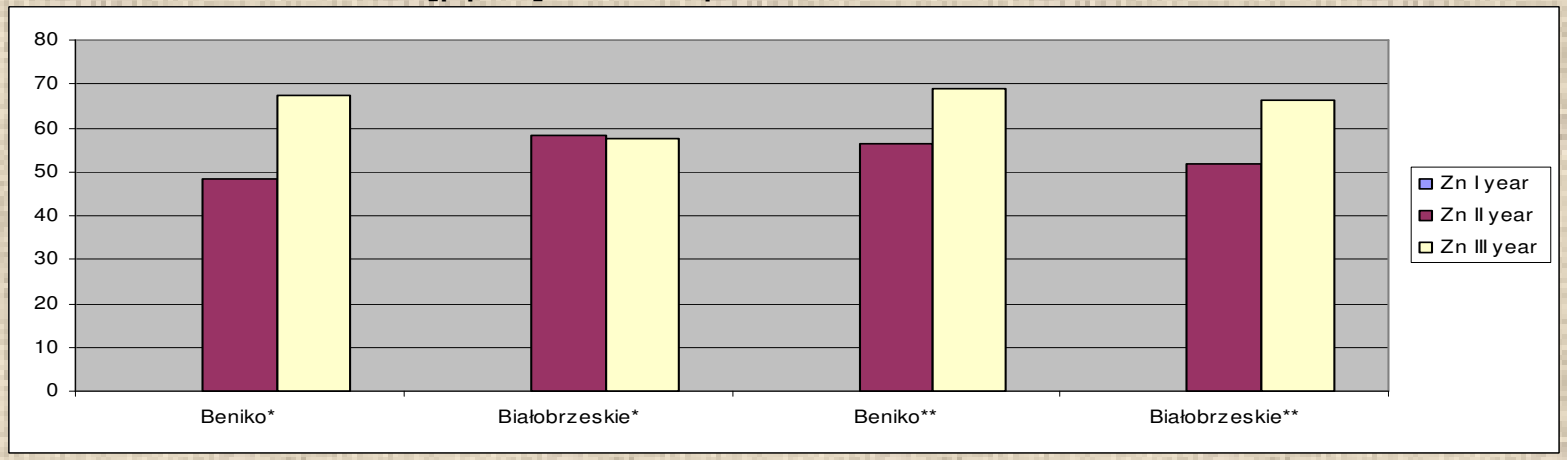


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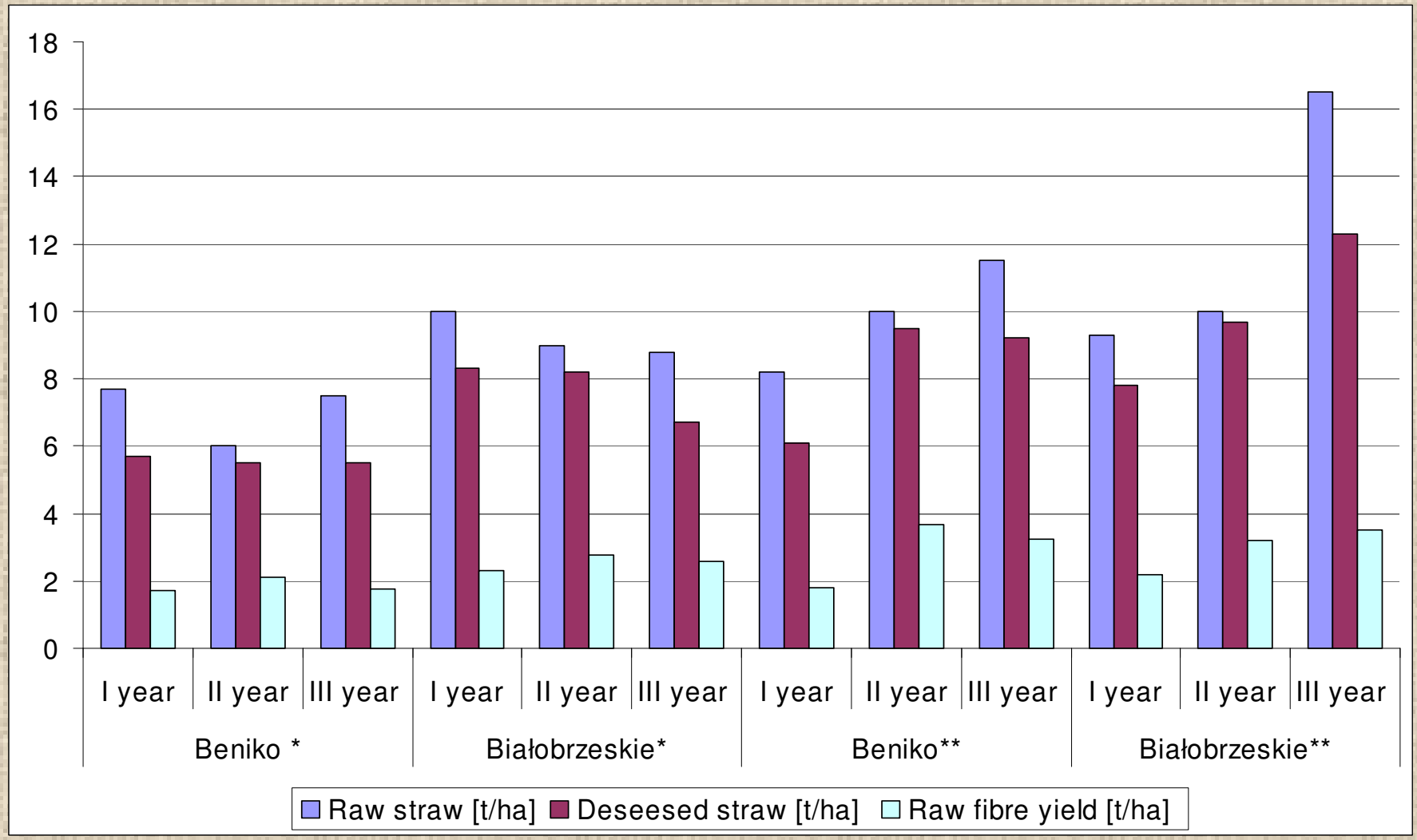
Table 3. Agronomical traits of the hemp from Biechów area

Cultivar	Beniko *			Białobrzeskie*			Beniko**			Białobrzeskie**		
Traits	I year	II year	III year	I year	II year	III year	I year	II year	III year	I year	II year	III year
Raw straw [t/ha]	7.7	6.0	7.5	10.0	9.0	8.8	8.2	10.0	11.5	9.3	10.0	16.5
Deseeded straw [t/ha]	5.7	5.5	5.5	8.3	8.2	6.7	6.1	9.5	9.2	7.8	9.7	12.3
Seed [t/ha]	0.20	0.11	1.27	0.17	0.40	0.67	0.17	0.10	1.06	0.16	0.27	1.15
Total length of straw [cm]	211	235	230	235	245	180	221	280	195	202	300	220
Technical length of straw [cm]	184	195	195	208	205	165	192	240	175	176	270	195
Straw thickness [mm]	5.8	5.5	7.1	7.0	5.0	4.0	6.0	8.0	6.8	51	5.0	7.5
Raw fibre efficiency [%]	30.2	38.0	32.7	27.5	34.0	38.2	29.1	38.6	35.6	27.8	33.0	27.3
Raw fibre yield [t/ha]	1.72	2.09	1.76	2.30	2.79	2.56	1.80	3.67	3.26	2.20	3.20	3.52

*fertilization variant: 60 kg N; 70 kg P2O5; 90 kg K2O

**fertilization variant: 120 kg N; 100 kg P2O5; 180 kg K2O

Raw straw, desseded straw and raw hemp fibre yield from Biechów area



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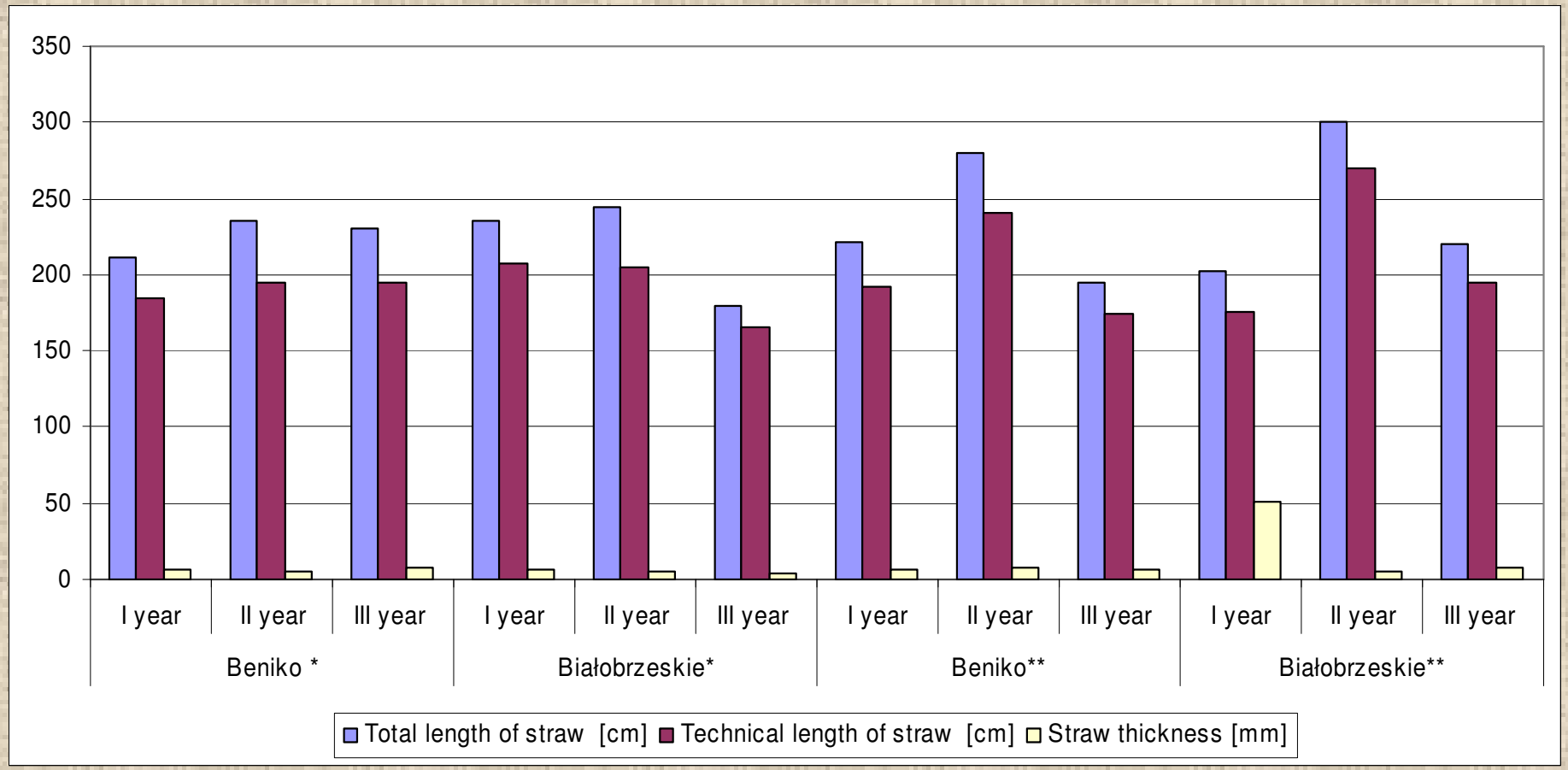
Total length, technical length and hemp straw thickness from Biechów area



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Seed yield from Biechów area

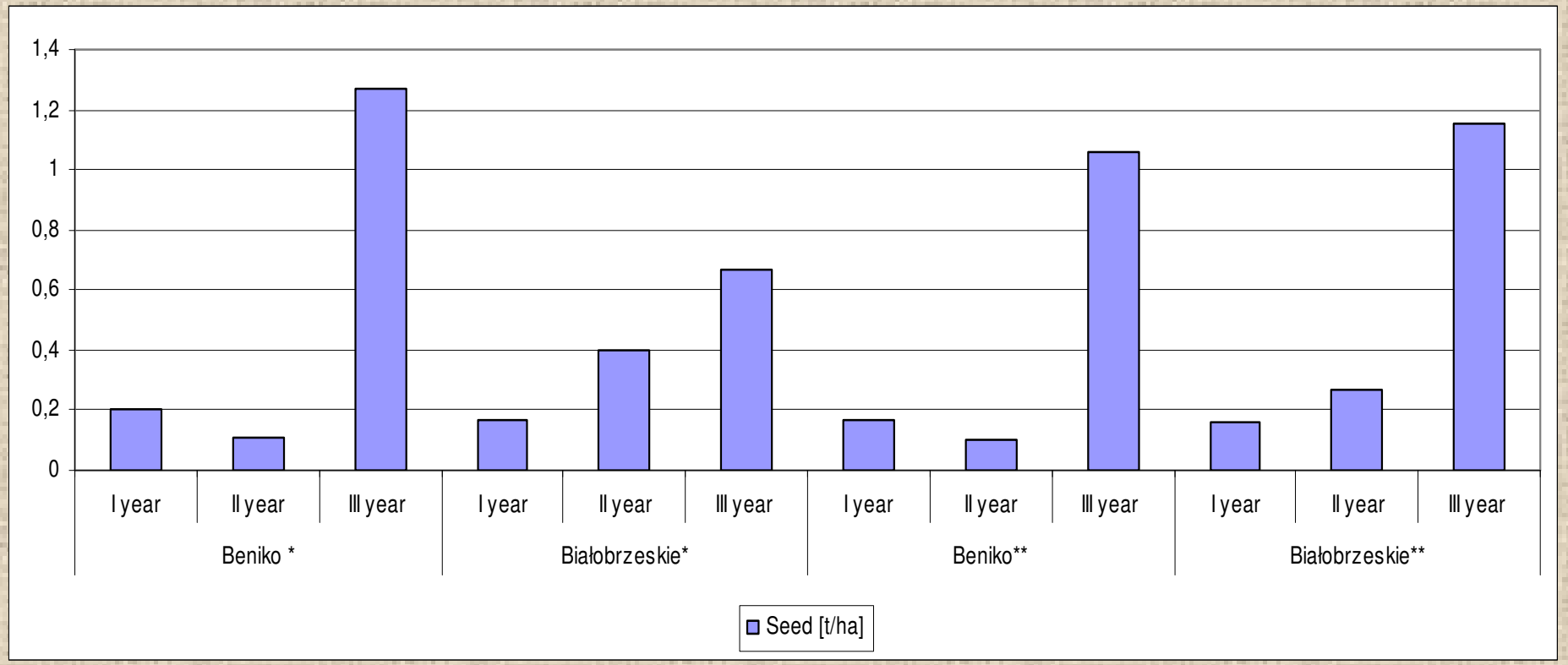

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Table 4. Agronomical traits of the hemp from Żukowice area

Cultivar	Beniko *			Białobrzeskie*			Beniko**			Białobrzeskie**		
Traits	I year	II year	III year	I year	II year	III year	I year	II year	III year	I year	II year	III year
Raw straw [t/ha]	-	8.0	6.5	-	10.0	7.5	-	6.7	9.0	-	8.0	7.5
Ginned straw [t/ha]	-	7.4	5.4	-	9.0	6.4	-	5.7	7.5	-	6.9	5.5
Seed [t/ha]	-	0.14	0.75	-	0.46	0.63	-	0.22	0.74	-	0.19	1.06
Total length of straw [cm]	-	195	165	-	220	180	-	240	155	-	245	195
Technical length of straw [cm]	-	165	150	-	190	164	-	205	135	-	210	175
Straw thickness [mm]	-	4.0	3.7	-	4.0	5.8	-	6.0	5.0	-	5.5	6.8
Raw fibre efficiency [%]	-	35.5	27.0	-	35.0	38.4	-	33.9	25.4	-	28.8	35.6
Raw fibre yield [t/ha]	-	2.63	1.44	-	2.80	2.46	-	1.93	1.91	-	1.99	1.96

*fertilization variant: 60 kg N; 70 kg P2O5; 90 kg K2O

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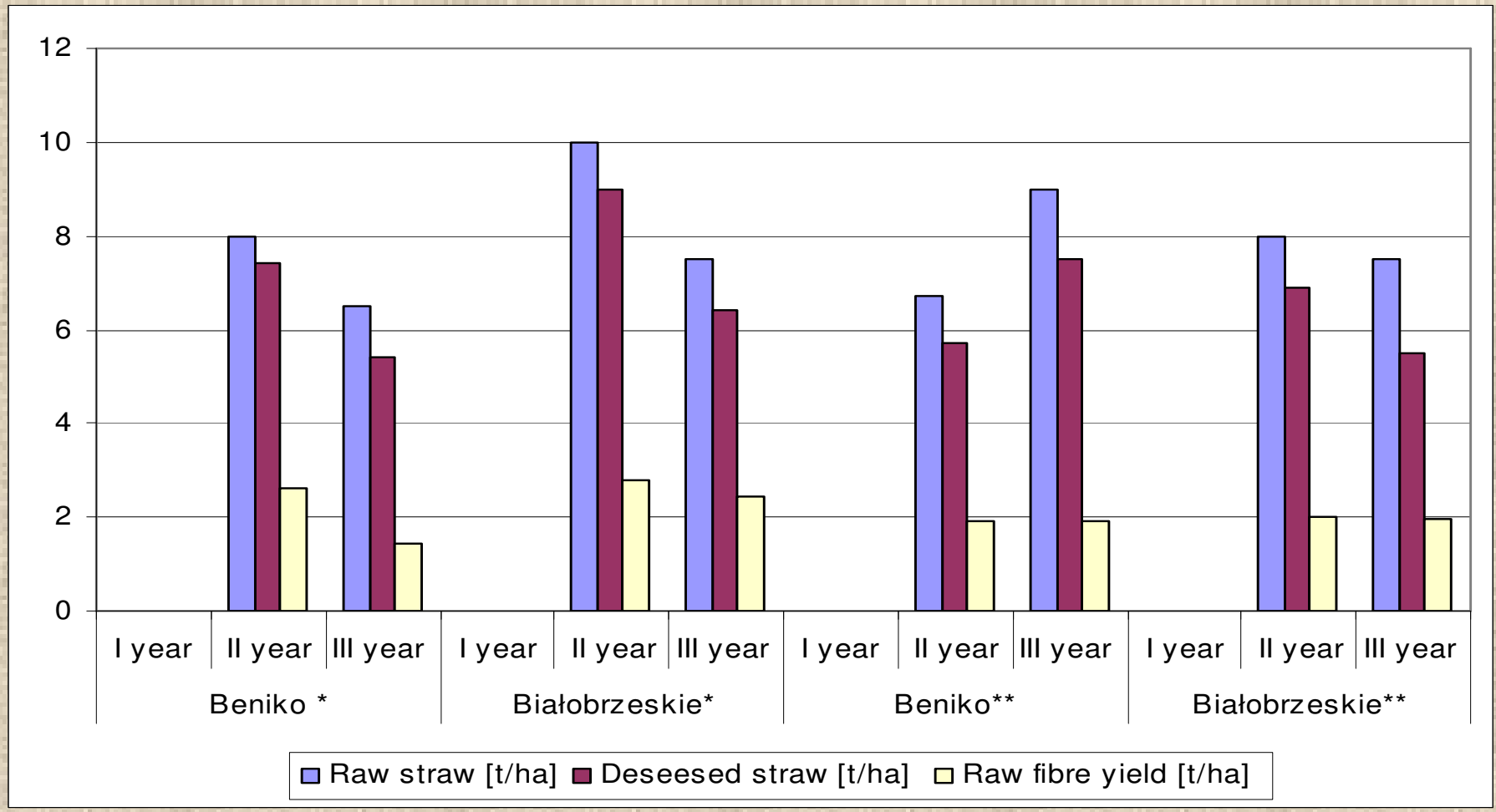
Raw straw, desseded straw and raw hemp fibre yield from Żukowice area



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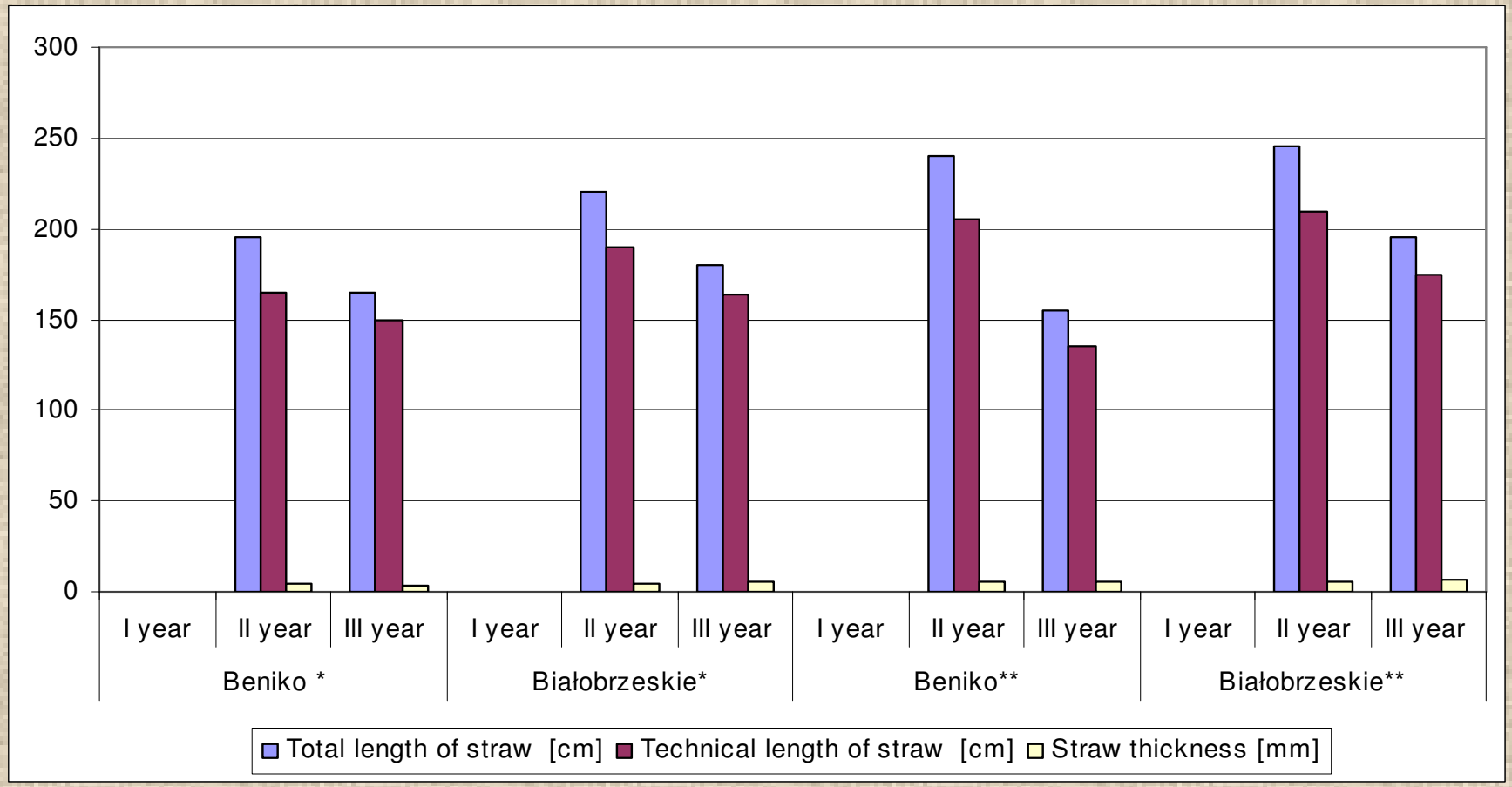
Total length, technical length and hemp straw thickness from Żukowice area



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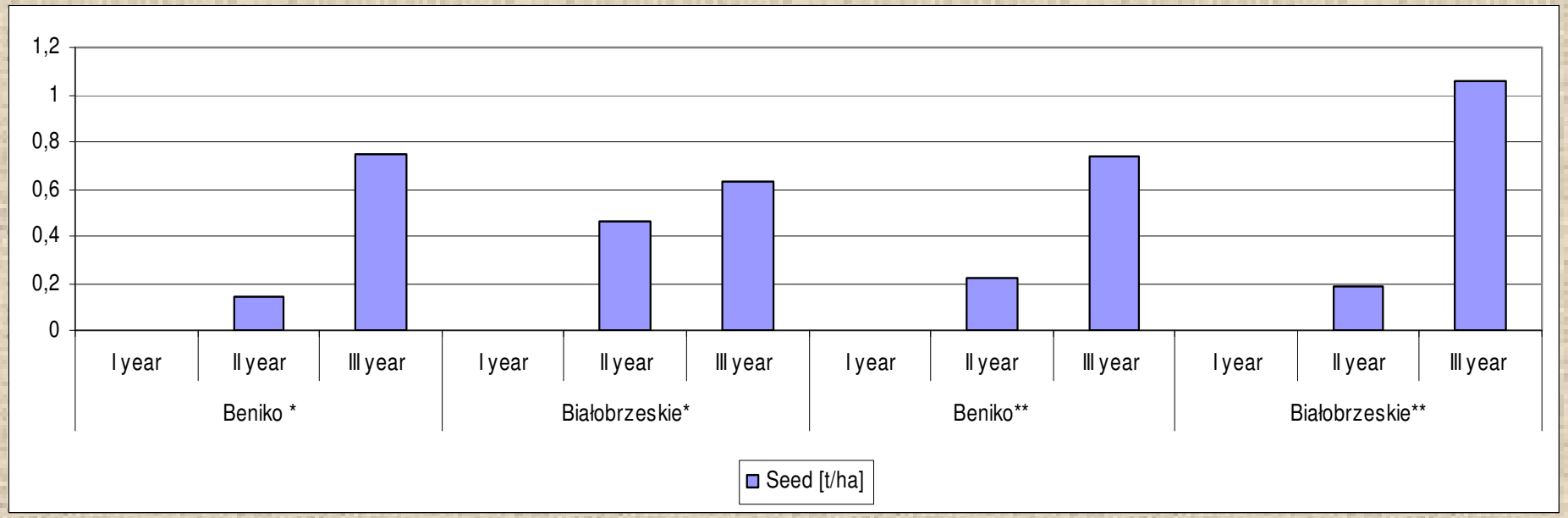
Seed yield from Żukowice area



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CONCLUSIONS

1. The presence of heavy metals in the soil showed no unfavorable effect on plant growth, development, and yield of cultivated plants.

2. Hemp growing on polluted area extract up to 0,13 ppm of Cadmium, 27 ppm of Copper, 4 ppm of Lead and 75 ppm of Zinc. Only Copper level in the safety buffer zone of Copper Plant in Głogów was considerably above allowable concentrations.

3. The phenomena of accumulation of heavy metals in the seed and roots can be explore for soil phytoremediation.

4. Industrial plants not direct used for food and fodder can be used for cleaning of degraded soils.

5. The utilization of biomass obtained from hemp as an alternative raw material for different kinds of industry will have the positive effect on the natural environment, will exclude heavy metals from the nutritive chain of humans, will limit the exploitation of forests and non-renewable resources.